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Section 10
Potable Water System Analysis

The purpose of this section is to present the results of the hydraulic analysis of the water system and its ability to meet current and projected water demands through the year 2023. This section is divided into three main sections; the first portion of this section presents the development and calibration of the hydraulic model of the water system. The second portion discusses the ability of the existing water system to meet current and projected demands; in this section, water system improvements are identified for each of the main segments in the existing transmission system. The third and last portion of this section presents the results of the hydraulic evaluation of the different water system alternatives that were evaluated as part of this study.

10.1 Model Development and Calibration

10.1.1 Model Development

Prior to the beginning of this master plan, CESPT had acquired Cybernet, a hydraulic modeling software, and began developing a model of the system. The early model included the most of the main transmission pipelines in the system. The alignment of these pipelines was roughly digitized and some of the hydraulic parameters identified.

CDM evaluated a number of computer models available in the market prior to selecting the recommended model. The evaluation was based on the models ability to model a number of static and dynamic conditions, integration with GIS platforms, and the initial and maintenance cost to operate the models. CDM recommended H2OMap Water for the development of the water system hydraulic model. Similar recommendation was made on the wastewater side where H2OMap Sewer was recommended.

As part of the model development, water system facilities were classified into three different levels. They are as follows:

- Level 1 facilities correspond to the main transmission facilities (aqueducts) (generally larger than 20 inches in diameter), main pump stations, and larger reservoirs (generally those with a capacity greater than 5,000 cubic meters).

- Level 2 facilities include main transmission lines between the main aqueducts and secondary reservoirs (those with a storage capacity less than 5,000 cubic meters), between reservoirs and smaller pump stations.

- Level 3 facilities correspond to all distribution pipelines and remaining facilities in the water system.

The model developed for this master plan includes all Level 1 and some of Level 2 facilities. The model contains approximately 370 pipelines, 350 nodes, 21 reservoirs, and 3 pump stations. The type of data required for each the model elements includes the following:

- Pipelines: length, diameter, material of construction, and year of construction
- Nodes: ground surface elevation and water demands
- Reservoirs: ground surface elevation, year of construction and capacity
- Pumps: horsepower (no pump curves were available)
- Water treatment plants: water surface elevation

As part of developing the hydraulic model, it is important to note the following issues:

- Pipeline alignments were identified, by digitizing over the water system facilities maps provided by CESPT.
- Pipeline lengths were calculated automatically, by the model since the base maps were to scale.
- Pipeline diameters were based on those depicted on the water system facilities maps.
- Node elevations were determined using the water and wastewater base maps.
- In the large majority of cases, node elevations were identified by direct interpolation between two or three known points. However, there were some instances where the known points were too distant to interpolate and elevations had to be approximated. Yet, in some other cases, where no information was available on terrain elevation, node elevations were assumed. Node elevations that were approximated or just assumed had been noted in the model.
- Reservoir elevations obtained from the Catastro database were assumed to be ground surface elevations. In most cases, it was assumed that the maximum water surface elevations were 3 m (10 ft) higher than the ground surface elevation unless specific information about individual reservoirs was available.
- In the absence of pump curves for the individual pump stations, a 65 percent efficient was assumed.

10.1.2 Model Calibration

The calibration of a hydraulic model is an important step to make sure that field conditions are properly represented by the model. To assess field conditions, a series of pressure reading charts and flow meters were installed at specific locations in the system and information was obtained over a two day period (August 8th and 9th, 2002). Because of the limited number of daily pressure recording charts, the Florido-Otay-Aeropuerto system was monitored during the first day while monitoring of the Florido-Aguaje-Playas was conducted on the second day. Weekly pressure recording charts were installed along the Rodriguez-Morelos Aqueduct. The location of the pressure recording charts is depicted in Figure 10-1.

Flow rates at known locations were also monitored to determine how much water was being conveyed in each aqueduct. Pitot tubes were installed at the two main aqueducts just downstream of the El Florido Water Treatment Plant. Flow rates at existing meters were also recorded during this period. Calibration was conducted over an eight hour period during which flow rates were manually recorded approximately every hour. Average deliveries from El Florido Treatment Plant were 3,714 l/s on August 8th and 3,762 on August 9th. Figure 10-1 also depicts the location of the flow monitoring points.

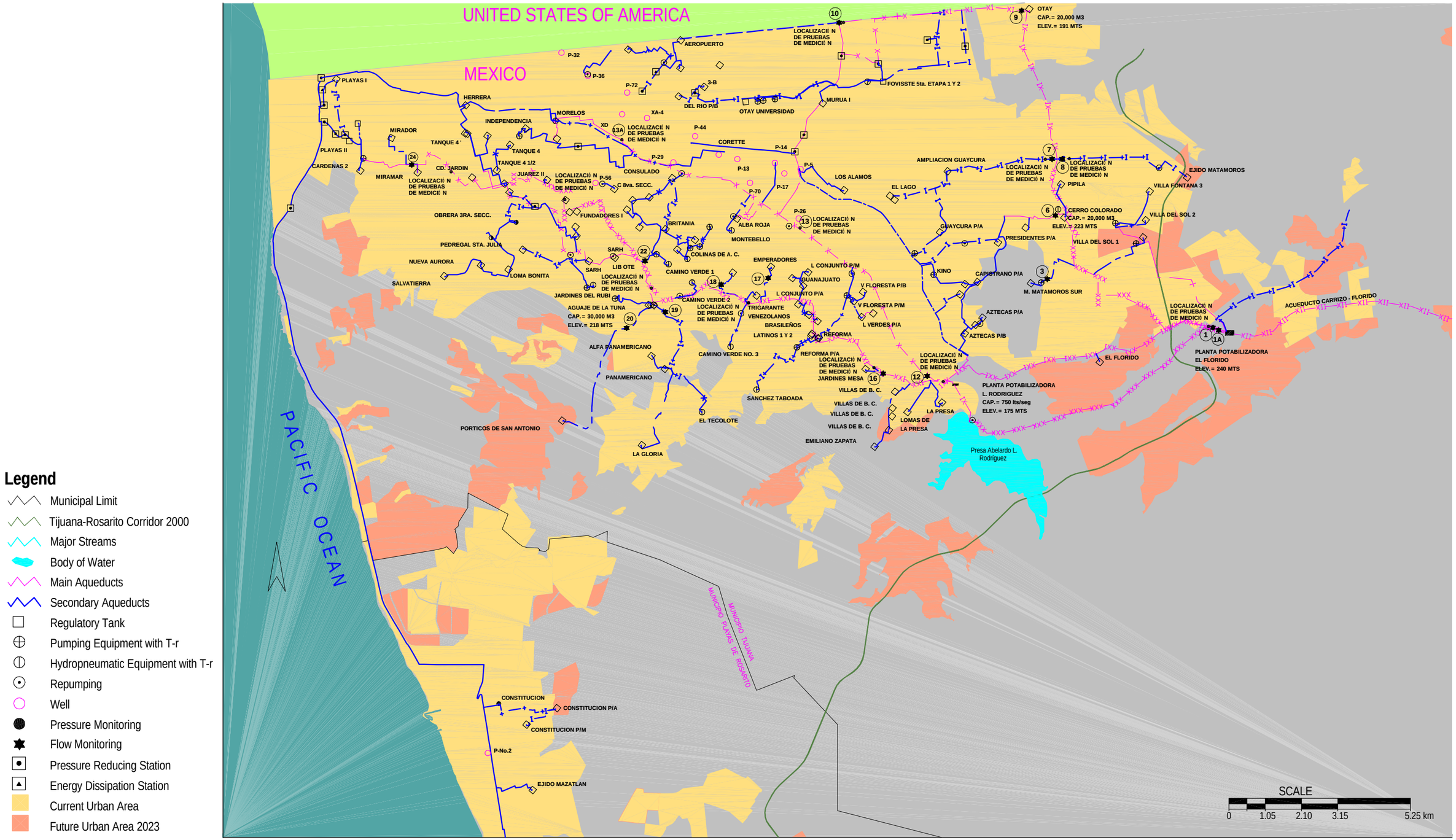
The information collected in the field was compiled and processed for inclusion into the hydraulic model. The model was ran and adjustments were made to reflect field conditions. The final results of the calibration process for each of the three aqueducts are discussed below. The calibration objective was to replicate field conditions within 10 psi.

10.1.2.1 Aqueduct El Florido-Otay-Aeropuerto

Four monitoring locations were evaluated along this aqueduct on Thursday, August 8, 2002. The results of the evaluation are as follows:

- Location No. 1 is located just downstream of the El Florido Water Treatment Plant over the existing 48 inch diameter pipeline. Pressures recorded ranged from 45 to 50 psi indicating that the topographic elevation of this site is approximately 210 meters.

- Location No. 7 is located along the Guaycura pipeline off the Cerro Colorado-Otay Aqueduct at an elevation of 185 meters. Pressures recorded at this site were constant over the entire day at 90 psi. The reason the pressures were constant is because of the close proximity of the Cerro Colorado Reservoir. Additional evaluation of this site is presented below under Location No. 8.



Legend

- Municipal Limit
- Tijuana-Rosarito Corridor 2000
- Major Streams
- Body of Water
- Main Aqueducts
- Secondary Aqueducts
- Regulatory Tank
- Pumping Equipment with T-r
- Hydropneumatic Equipment with T-r
- Repumping
- Well
- Pressure Monitoring
- Flow Monitoring
- Pressure Reducing Station
- Energy Dissipation Station
- Current Urban Area
- Future Urban Area 2023

Figure 10-1
Location of Calibration Monitoring Stations (2002)

CDM

- Location No. 8 is located within sight distance of Location No. 7 along the Ejido Matamoros pipeline and at the same elevation. Pressures recorded at this location were a constant 20 psi lower than Location No. 7. This is a puzzling situation for two reasons:

  - Pressures should be the same unless an unknown partially close valve is located between the Cerro Colorado-Otay Aqueduct and the monitoring location that is responsible for the pressure differential.

  - Pressures recorded by both monitors do not make sense because a 70 psi pressure (49 m) would result in a hydraulic gradient of approximately 234 m, which is higher than the water level at the Cerro Colorado Reservoir. Hydraulically this situation can only occur if water is boosted from this reservoir to the Otay Reservoir, which it does not happen. A 90 psi reading (63 m) at Location No. 7 would put the hydraulic gradient at 248 m, which is higher than both the Cerro Colorado Reservoir and the El Florido Water Treatment Plant. Our conclusion is that both pressure recording devices were not functioning properly.

  - Modeling results indicate that pressures at both locations should be between 55 and 58 psi.

- Location No. 10 is located in the vicinity of the Garita de Otay colonia at an approximate elevation of 155 m. Pressures recorded at this site ranged from 60 to 70 psi. Once again, this creates an illogical situation. A 60 psi pressure (42 m) would result in a hydraulic grade of approximately 197 meters, which is higher than the Otay Reservoir. The hydraulic grade in this area can only be higher if the international connection was open at that time. CESPT records indicate that this connection was closed. Modeling results indicate that pressures at this location should be approximately 48 to 51 psi.

10.1.2.2 Aqueduct El Florido-Aguaje-Playas

Five monitoring locations were evaluated along this aqueduct on Friday, August 9, 2002. The results of the evaluation are as follows:

- Location No. 16 is located in the vicinity of the connection to the Jardines de La Mesa Reservoir over the main aqueduct at an elevation of approximately 164.50 meters. Field recorded pressures were at a constant 90 psi while modeling results indicate 92 psi. This pressure is considered within the calibration objective.

- Location between points 17 and 18 is located in the vicinity of the connection to the Camino Verde No. 3 Reservoir at an elevation of approximately 189 meters. Field recorded pressures ranged between 49 and 55 psi while modeling results indicate 53 psi and close to the middle portion of the field range. This pressure is considered within the calibration objective.

- Location between Aguaje de La Tuna and point 22 is located downstream of the reservoir at an elevation of approximately 190 m. Field recorded pressures ranged between 110 and 115 psi while modeling results indicate only 47 psi. The field recorded pressures of 110 psi do not make sense because they will result in a hydraulic grade much higher than the Aguaje de La Tuna. The only way that this may make some sense is if the pressure recording chart was in feet since a pressure of 47 psi is equivalent to 108 ft. This may be the same recording device used at Location No. 7 or 8 during the previous day.

- Location Fundadores 2 Reservoir is located just south of the connection point to the Juarez Reservoir at an elevation of approximately 205 m. Pressures recorded at this site ranged from 2 to 15 psi while modeling results indicate 11 psi. This pressure is considered within the calibration objective.

- Location between 4½ and Miramar Reservoir is located at an elevation of approximately 153.5 m. Field recorded pressures oscillated between 70 and 80 psi while modeling results indicated 76 psi. This pressure is considered within the calibration objective.

10.1.2.3 Aqueduct A.L. Rodriguez to Morelos Reservoir

Three monitoring locations were evaluated along this aqueduct on both days. The results of the evaluation are as follows:

- Location No. 12 is located along the pipeline that conveys water from the El Florido – Aguaje Aqueduct to the oscillation tower at the A.L. Rodriguez Water Treatment Plant. According to the wastewater system maps, the elevation of this location is approximately 83.5 m. Field recorded pressures ranged between 20 and 25 psi (17.6 m) at this location, which will put the hydraulic grade at approximately 101 m which is some 25 m higher than the published elevation for the A.L. Rodriguez Water Treatment Plant of 75 m. This location is considered not a good location to monitor because it is under the hydraulic influence of the perforated plates used to reduce pressure from the Florido-Aguaje Aqueduct. It should be noted however, that as a result of this analysis, the hydraulic elevation of the A.L. Rodriguez Water Treatment Plant was revised to reflect the ground elevation in that vicinity.

- Location No. 13 is located in the Colonia Chapultepec California at an elevation of approximately 61.6 m. Field recorded pressures were approximately 25 psi since the ink smeared as a result of humidity. Modeling results indicate a pressure of 23 psi. This pressure is considered well within the calibration objective.

- Location No. 13-A is located in the Colonia Marron at an approximate elevation of 39 m. Field recorded pressures ranged from 40 to 60 psi while modeling results indicate 39 psi at the low end of the range. This pressure is considered within the calibration objective.

Overall, the Florido-Aguaje-Playas and the Rodriguez-Morelos Aqueducts are considered calibrated. However, additional information is required to assess the Florido-Otay-Aeropuerto Aqueduct.

10.2 Analysis of the Water System Facilities in the Currently Developed Areas

As described in previous sections, the primary source of water for the existing service area is from the Colorado River through the El Florido Water Treatment Plant. In the future, this area will be supplied by a combination of this existing source and a new desalting plant to be located in Playas de Rosarito. The alternatives considered to meet projected water demands for the year 2023 are presented in Section 9, while the evaluation process is discussed in Section 12.

An evaluation of the water supply distribution system that identifies necessary improvements for current and future conditions must be done for each one of the 12 alternatives presented in Section 9. The design criteria utilized for the evaluation of the system are presented in Appendix Q.

It is important to bring forward the results of the modeling exercise, which discusses in detail the simulation and results for Alternative F-E, the preferred alternative, in Section 12. This section also presents the modeling results for the rest of the alternatives.

Under Alternative F-E, the desalination plant will become a significant supply source to the current service area. It is anticipated that once this facility becomes operational and some conveyance lines are constructed, part of the water from this supply source will be conveyed to the Playas II and Panamericano tanks. The delivery rates from the desalination plant will increase as the urban area continues to expand and the current flows from El Florido Water Treatment Plant are used elsewhere in the system.

Ultimately, deliveries of desalted water to the Playas 2 Reservoir will serve the Playas 2, Miramar, 4½, Herrera, and portions of the Morelos services areas. Similarly, deliveries of desalted water to the Panamericano Reservoir will be conveyed by gravity to the Aguaje de La Tuna Reservoir and served the Mexico-Juarez, Ferias, Fundadores 1 and 2, Tejamen, Aguaje de La Tuna, Rubi-Sarh, and Obrera 3ra Section. Since the areas served by desalted water represent a significant portion of the current system it is important to bring forward the preferred alternative in this section. The analysis of the existing system and the recommended improvements are therefore based on bringing significant amounts of desalted water to the westerly portion of the currently developed service area.

The sizing of the facilities is based on the sizing criteria presented to and approved by CESPT for maximum velocities, minimum pressures, and maximum head losses in the system under maximum day demand conditions. The analysis of the system is

presented one segment at a time. For each segment, the current and projected sources of water are described as well as the immediate and long-term deficiencies identified. Improvements are recommended for each segment. The analysis is presented from the terminus delivery points back to the supply sources.

As indicated earlier, the El Florido Water Treatment Plant comprises the main source of water to the currently developed area. Sources from this plant are conveyed to the service area through two main aqueducts; namely, the Florido-Aguaje and the Florido-Otay Aqueducts. A third smaller aqueduct is currently being developed to serve the Fiadert area. These three aqueducts work independently of each other and represent the initial system subdivision. For each of these aqueducts, the analysis of the existing system is presented from the most distant delivery points backwards to El Florido Water Treatment Plant. Each of these aqueducts is further subdivided into main segments and these segments into smaller segments to provide a more clear depiction of current conditions in the different portions of the system and how they will be impacted as the area continues to developed and new supply sources become available. The analysis of each of the main segments of the system addresses transmission, pumping, and storage facilities.

10.2.1 Analysis of the El Florido – Aguaje de La Tuna Aqueduct

This aqueduct currently serves all the developed areas on the southerly side of the Tijuana River including Zona Rio, Playas de Tijuana, and Playas de Rosarito. To simplify the analysis of this large portion of the CESPT overall service area, this aqueduct is divided into three main segments as follows:

- Aguaje de La Tuna to Playas de Tijuana including the Rubi-Sarh, Obrera, and Panamericano systems
- A.L. Rodriguez Water Treatment Plant to Aguaje de La Tuna including the Sanchez Taboada system
- Zona Rio system including the Herrera and Playas de Rosarito system
- El Florido Water Treatment Plant to the A.L. Rodriguez Water Treatment Plant

10.2.1.1 - Analysis of the Aguaje de La Tuna – Playas de Tijuana Section

The large majority of this section of the aqueduct is supplied by gravity by the Aguaje de La Tuna Reservoir. Water flows from this reservoir to the 4½ Reservoir and subsequently to the Miramar, Lazaro Cardenas, Playas 2 and Playas 1 Reservoirs. A good portion of this system is also served by pump stations such as the case of the Rubi-Sarh and Panamericano systems. To simplify the analysis, this section of the aqueduct is further subdivided into four smaller and distinct segments as follows:

- 4½ Reservoir to the Playas 1 Reservoir

- Aguaje de La Tuna to the 4½ Reservoir
- Aguaje de La Tuna to the Obrera Reservoir
- Panamericano Reservoir system

10.2.1.1.1 Analysis of the 4½ Reservoir to Playas 1 Reservoir Section

This portion of the system is currently fed by gravity from the Aguaje de La Tuna Reservoir. Upon completion of the desalting facility in Rosarito and delivery pipelines, desalted water will be delivered to the Playas 2 Reservoir. From this reservoir, it will be pumped back towards the Miramar and 4½ Reservoirs. From this later reservoir, it will be fed by gravity to the Herrera Reservoir. The analysis of this segment is therefore further segregated into several segments as presented below.

Playas 2 to Playas 1 Segment

Water will be delivered by gravity from Playas 2 to Playas 1. The existing pipeline between these reservoirs (300 mm - 12") is adequate to meet current demands; however, as the area continues to develop and demands increase, a parallel pipeline will be needed. It is therefore recommended that by the year 2013 a parallel 300 mm (12") diameter pipeline be constructed. The estimated length of this pipeline is 2,000 meters (6,500 ft).

Miramar to Playas 2 Segment

Currently water is delivered by gravity from the Miramar Reservoir to the Playas 2 Reservoir. Once the desalting facility is constructed, the reverse will occur. It is anticipated that deliveries of desalted water to the Playas 2 Reservoir would range from 370 l/s initially to 510 l/s by the year 2023. This will require the construction of a pump station at this reservoir and a new pipeline to convey the required flows to the Lazaro Cardenas 2 Reservoir. The existing pipeline (350 mm to 380 mm – 14 to 15" in diameter) does not have enough capacity to convey the initial deliveries. It is therefore recommended that a parallel 610 mm (24") in diameter be constructed. The estimated length of this pipeline is 800 meters (2,500 ft).

At the existing Lazaro Cardenas 2 Reservoir is recommended that the existing and proposed pipelines be isolated from the reservoir. The reservoir should be considered as a delivery point fed by the main line between the Miramar and Playas 2 Reservoirs. There are two reasons for this recommendation; first, it will eliminate the need for a pump station at this site to supply the Miramar Reservoir. Second and more important, the elevation of this reservoir (Cardenas) is not high enough to provide adequate pressures along the pipeline that currently supplies the Playas 2 Reservoir. This recommendation should be implemented even before the desalination plant becomes operational since the operational heads along that segment are fairly low.

The recommended pump station at the Playas 2 Reservoir should be constructed in parallel with the desalting facilities and should consist of a 400 Hp pump station capable of providing 510 l/s (8,100 gpm) at an estimated discharge head of 35 m (115 ft). A 70 percent efficiency has been assumed for all proposed pump stations.

4½ to Miramar Segment

Under current operating conditions, the 4½ Reservoir feeds by gravity the Miramar Reservoir. The existing 760 mm (30") diameter pipeline between these reservoirs is adequate to meet current maximum day demands conditions. Upon completion of the desalination facility in Rosarito, this pipeline will be used in the opposite way conveying desalted water into the 4½ Reservoir. It is anticipated that deliveries of desalted water would range from 306 l/s initially to 341 l/s by the year 2023. This will require the construction of a 100 Hp pump station at the Miramar Reservoir capable of conveying the maximum flows at an estimated operating head of 12 meters (39 ft). The existing pipeline between these reservoirs is adequately sized to convey ultimate flows.

4½ to Herrera Segment

The anticipated supplies from the desalting facility in Rosarito would exceed the estimated demands for the service areas of the Playas 2, Miramar, and 4½ Reservoirs. Excess supply capacity for ultimate conditions, estimated at 183 l/s (2,900 gpm), could be used to supply a portion of the demand between the 4½ Reservoir and the Aguaje de La Tuna Reservoir or it could be delivered towards the Herrera and Morelos Reservoirs. In either case, pumping will be required at the 4½ Reservoir.

While the 4½ Reservoir (elevation 208 m) is located at a significantly higher elevation than the Herrera Reservoir (elevation 141 m), the pipeline that connects them, a 510 mm (20") diameter pipeline, runs along a relatively high ground that results in minimum operating pressures along the first half of this section. The low operating head along this section of the pipeline severely limits the conveyance capacity of this facility. By pumping at the 4½ Reservoir to an elevation of approximately 224 m (735 ft), the operating pressures along the first half of the Herrera pipeline will increase to 25 to 40 psi. Conversely, the second half of the pipeline currently experiences significantly high pressures that can be regulated by installing a pressure reducing station at the *existing* 4' Reservoirs (No. 31711 and 31712).

The pump station at the 4½ Reservoir should consist of a 60 Hp pump station capable of pumping 183 l/s (2,900 gpm) at an operating head of approximately 16 m (52 ft).

It should be noted that under the proposed supply configuration, the Herrera Reservoir would no longer be used to convey water to Rosarito since the desalination facility will provide the necessary supply for that community. The Herrera Reservoir would be used to meet daily operating requirements for its service area and a portion of the Zona Rio through the Morelos Reservoir.

Storage Analysis for the Area Downstream of the 4½ Reservoir

The maximum day demand for the year 2023 for the area downstream of the 4½ Reservoir, comprised by the Playas, Miramar, and 4½ Reservoir service areas, is estimated at 483 l/s (7,650 gpm). The recommended storage capacity for this area is estimated at 13,900 m^3, which is lower than the current capacity of 19,300 m^3. Therefore, no additional capacity is recommended in the short term. However, if some of the tanks need to be replaced, the additional capacity should be installed at the elevation of tank 4½. The current storage capacity is as follows:

Component	Capacity (m3)
Tanque 4-½	1,000 m3
Miramar	1,000 m3
Mirador	2,000 m3
Lázaro Cárdenas 1	1,200 m3
Lázaro Cárdenas 2	1,000 m3
Playas 2	5,000 m3
Playas 1	2,700 m3
Ciudad Jardín	2,000 m3
Tanque 4	1,400 m3
Francisco Villa	2,000 m3

While the storage shortage for this area is only 1,000 cubic meters, it is recommended that additional storage be provided since some of these reservoirs may not be fully operational. The recommended storage, 5,000 cubic meters, should be located in the vicinity of the 4½ Reservoir and at the same elevation.

Storage Analysis for the Herrera Reservoir

The maximum day demand for the year 2023 for the Herrera service area is estimated at 102 l/s (1,600 gpm) resulting in a storage requirement of 2,940 cubic meters. The current storage capacity of the Herrera Reservoir (5,000 cubic meters) is sufficient to meet the year 2023 requirements.

10.2.1.1.2 Analysis of the Aguaje de La Tuna to the 4½ Reservoir Section

This portion of the system consists of a 1,220 mm (48 inches) in diameter pipeline that feeds by gravity the following systems: Mexico-Juarez, Fundadores 1 and 2, Ferias, Tejamen and Aguaje de La Tuna 1 and 2 and other smaller systems. In addition, this pipeline conveys the flows to the 4½ Reservoir and the areas downstream of this reservoir. Upon completion of the desalting facility in Rosarito and delivery pipelines, desalted water will be delivered to the Aguaje de La Tuna Reservoir through the Panamericano system. A change in the supply source will not represent a change in operations of the water transmission and distribution facilities for this section.

The analysis of the system under maximum day demand indicates that the existing facilities are capable of supplying the estimated demands for the above listed systems; however, operating pressures are very high, exceeding 150 psi, along the aqueduct between the connection to the Rubi-Sarh Reservoir and just before the Fundadores 1 connection. The high pressures along the main pipeline are not a problem as long as the pressure is reduced when connecting to the smaller sub-systems. Direct services off this line are not recommended because it will result in significant leaks in the system.

Conversely, there is a point in between the Fundadores 2 and Mexico-Juarez connection where the pressure is very low (less than 5 psi). This point, located along Fundadores Blvd., is located at a relatively high elevation (218.6 m), which results in low operating pressures since the hydraulic gradient of the Aguaje de La Tuna Reservoir is just slightly above this elevation. The installation of an air-vacuum release valve should be implemented at this location if one does not exist now.

Upon completion of the desalting facility and delivery of potable water to the Playas 2 Reservoir, this section of the aqueduct will not longer convey the flows to the 4½ and downstream areas and consequently will carry much reduced flows. No other improvements are proposed for this section of the aqueduct.

10.2.1.1.3 Analysis of the Aguaje de La Tuna to the Obrera Reservoir Section

This portion of the system serves the Libramiento Oriente, Rubi-Sarh, and the Obrera 3ra Seccion service areas. Under current conditions, water flows by gravity from the Aguaje de La Tuna to the Libramiento Oriente Reservoir. From this point, water is pumped to the Rubi-Sarh Reservoir from which the Obrera 3ra Seccion system is fed by gravity. Upon development of the desalting facilities there will be no change on the operations of this system only the supply source will change. The current maximum day demand for this system is estimated at 373 l/s (5,900 gpm); this demand is anticipated to increase to an estimated 516 l/s (8,200 gpm) by the year 2023.

Rubi-Sarh to Obrera 3ra Seccion Segment

Existing transmission facilities in this segment range from 406 mm (16 inches) to 760 mm (30 inches) in diameter. The current maximum day demand for the Obrera 3ra Seccion system is estimated at 145 l/s (2,300 gpm); this demand is anticipated to increase to 249 l/s (3,900 gpm) by the year 2023. The existing transmission facilities are capable of transmitting current and anticipated maximum demands. No improvements are recommended.

Libramiento Oriente to Rubi-Sarh Segment

Existing transmission facilities in this segment consist of a 610 mm (24 inches) in diameter pipeline. Water is pumped from the Libramiento Oriento Reservoir to the Rubi-Sarh Reservoir through the Obrera pump station. This pump station consists of three identical 400 Hp units. Normally, only two of the units operate at any given

time with the 3rd unit used for backup purposes. Assuming a 65 percent hydraulic efficiency, the existing Obrera pumping station is capable of conveying current and projected (2023) maximum day flows to the Rubi-Sarh Reservoir. No improvements are recommended for this segment.

Aguaje de La Tuna - 4½ Reservoir Aqueduct to Libramiento Oriente Segment

Existing transmission facilities along this segment range in diameter from 910 mm (36 inches) to 1,067 mm (42 inches). The facilities are properly sized to convey current and projected maximum day demand flows. No improvements are recommended for this segment.

Storage Analysis for the Libramiento de Oriente to Obrera Section

Based on the current maximum day demand (373 l/s) for this portion of the system, the storage requirements are estimated at 10,750 cubic meters. Projected maximum day demands for the year 2023 of 516 l/s will increase the storage requirement to 14,875 cubic meters. The current storage capacity in this area is estimated at 23,500,, including some secondary tanks, cubic meters segregated as follows:

Component	Capacity (m^3)
Obrera	5,000
Jardines del Rubí	1,000
Rubí – Sarh	5,000
Tanque No. 6	1,500
Libramiento Oriente	1,000
La Cima	2,000
Fundadores Norte	1,500
Loma Bonita	1,500
Nueva Aurora	3,500
Salvatierra	1,500

No additional storage is recommended for this portion of the system. The local storage has enough capacity to meet current requirements while the Aguaje de La Tuna provides the additional capacity for the projected 2023 requirements.

Storage Analysis for the Aguaje de La Tuna System

The current maximum day demand for the area downstream of the Aguaje de La Tuna, which includes the 4½ system and the Rubi-Sarh system, is estimated at 1,095 l/s (17,400 gpm). Maximum day demand is projected to increase to an estimated 1,752 l/s (27,800 gpm). The storage requirement for this area is estimated at 31,500 cubic meters for current conditions and 50,500 cubic meters for 2023 conditions.

The current storage capacity exceeds the current and projected requirements and it is comprised by the following storage facilities:

Component	Capacity (m^3)
Aguaje de La Tuna	30,000
4-½ – Playas	17,300
Libramiento Oriente	23,500

10.2.1.1.4 Analysis of the Panamericano Section

This portion of the system serves the service areas of the Panamericano, Tecolote, and Alfa Panamericano Reservoirs. Under current conditions, water is pumped from the Aguaje de La Tuna Reservoir to the Panamericano Reservoir by the Tecolote pump station through an existing 400 mm (16 inches) diameter pipeline. The other two reservoirs are fed by gravity off the Panamericano Reservoir.

As indicated earlier in this section, the Panamericano Reservoir will be one of two delivery points for desalted water produced by the Rosarito desalination plant. Under the recommended alternative (Alternative F-E), desalted water will be pumped from the desalter to the Panamericano Reservoir and then it will be conveyed by gravity into the Aguaje de la Tuna Reservoir. This will reverse the current mode of operation.

Current maximum day demand for the Panamericano system is estimated at 70 l/s (1,100 gpm). This demand is anticipated to increase to 139 l/s (2,200 gpm) by the year 2023. Assuming a 65 percent hydraulic efficiency, the existing Tecolote pumping station (400 Hp) is capable of conveying current maximum day flows to the Panamericano Reservoir. This station will not longer be needed once the desalted water becomes available.

Ultimately, an estimated 667 l/s (10,600 gpm) will be supplied by the Rosarito desalting plant to the Panamericano Reservoir for further conveyance to the Aguaje de la Tuna Reservoir. The existing 400 mm line could convey initial flows, but it should be converted to a distribution line for that reach and an independent 610 mm (24 inches) in diameter pipeline should be constructed. The estimated length of this pipeline is 2,650 meters (8,700 ft).

10.2.1.2 Analysis of the Rodriguez Plant Connection to Aguaje de la Tuna Section

The analysis of this segment comprises the aqueduct between these two points and the pumping system to the Sanchez Taboada Reservoir. Under the current configuration, this main aqueduct supplies all the areas downstream of the Aguaje de la Tuna Reservoir including the Rubi-Sarh and Panamericano pumping systems. In addition, it supplies the Aguas Calientes, Lomas Verdes (1, 2 and 3), Sanchez Taboada, Reforma, Villas de Baja California, Lomas de La Presa and a series of smaller systems off the main aqueduct. The existing transmission facilities along this segment consist of a 1,370 mm (54 inches) diameter pipeline is capable of conveying

the necessary flows to meet the current maximum day demand of its service area. The volume of water that this segment will carry in the future will be significantly reduced once desalted water becomes available at the Aguaje de la Tuna Reservoir.

With respect to the Sanchez Taboada system, it is supplied off the main aqueduct by the Sanchez Taboada pump station. This station has three identical 200 Hp pumping units with two of them used to meet operational demands and the third for backup purposes. This pump station has enough capacity to meet the current maximum day demand, estimated at 158 l/s (2,500 gpm). An additional 200 Hp pump will be required at this facility to convey the projected maximum demand for the year 2023 of 198 l/s (3,150 gpm). The adequacy of the existing suction and discharge pipelines at this station should be assessed before adding a new pumping can. The existing pipeline, a 410 mm (16 inches) diameter facility should be adequate to meet current and projected water demands in this area.

10.2.1.3 Analysis of the Zona Rio Section

This system comprises the Alba Roja and Morelos Reservoirs that serve the commercial and residential areas along the Tijuana River and it is also used to supply the Herrera and the majority of the Playas de Rosarito systems. Current maximum day demand for this entire system is estimated at 498 l/s (7,900 gpm). Presently, this system is supplied by a combination of Colorado River water from the Florido-Aguaje Aqueduct or local surface water treated at the Abelardo L. Rodriguez Water Treatment Plant when available. Water flows by gravity from this plant to the Alba Roja Reservoir and from this point to the Morelos Reservoir. At this location, the Morelos pump station supplies the Herrera and Playas de Rosarito systems. The analysis of this pipeline is discussed here for each of the reaches between reservoirs.

Analysis of the Alba Roja to Morelos Segment

Transmission facilities in this segment range in diameter from 610 mm to 760 mm (24 to 30 inches). These facilities are adequately sized to meet current maximum day demands between these reservoirs and to convey required flows to supply the Morelos pump station. Pressures along the majority of this segment are rather low (30 to 40 psi); this is due to the relative elevation of the Alba Roja and Morelos Reservoirs with respect to ground surface elevation. While there are alternatives to correct this situation, they may not be very practical to implement. Potential alternatives to correct low pressures along this area include the following:

- Abandon the existing Alba Roja and Morelos Reservoirs and construct new reservoirs at higher elevations. This will require pumping off the Rodriguez Water Treatment Plant.

- Pressurize the system at these two locations by constructing relatively large hydropneumatic stations

- Abandon the existing reservoirs and feed the system off the Aguaje de La Tuna to the 4½ Aqueduct.

While water demand will increase in the Zona Rio by the year 2023, the existing transmission facilities will be adequate to meet projected maximum day demands since they will not longer convey the supplies to Rosarito and the Herrera systems.

Analysis of the Rodriguez to Alba Roja Segment
Transmission facilities in this segment consist of a 760 mm (30 inches) diameter pipeline. These facilities are adequately sized to meet current maximum day demands between these reservoirs and to convey required flows to supply the areas downstream of the Alba Roja Reservoir including the Morelos pump station. Similar to the Alba Roja to Morelos segment, operating pressures along the majority of this segment are rather low (30 to 40 psi). Once again, this is due to the relative elevation of the Rodriguez Water Treatment Plant and the Alba Roja Reservoir with respect to ground surface elevation. Alternatives to correct this situation are the same proposed for the previous segment.

Storage Requirements for the Rodriguez to Morelos System
Current maximum day demand for the Herrera, Morelos and Alba Roja systems are estimated at 329 l/s (5,200 gpm). The recommended storage capacity for this area of 9,500 cubic meters for current conditions is anticipated to increase to 11,700 cubic meters as the maximum day demand increases to 407 l/s (6,500 gpm). The current storage capacity of this system, estimated at 15,000 cubic meters, is adequate to meet current and projected requirements. Storage facilities in this system include:

Component	Capacity (m^3)
Herrera	5,000
Morelos	5,000
Alba Roja	5,000

10.2.1.4 Analysis of the El Florido to Rodriguez Plant Section

Transmission facilities in this segment consist of a 1,370 mm (54 inches) in diameter pipeline and feed the Aguaje de La Tuna and Zona Rio systems. The hydraulics of this segment, are governed by operating water levels at the El Florido Water Treatment Plant and at the Aguaje de La Tuna Reservoir. The current maximum day demand for this entire system, estimated at 2,081 l/s (33,000 gpm), is anticipated to increase to 3,350 l/s (53,000 gpm) by the year 2023. Currently, the Florido Water Treatment Plant provides the large majority of the supply system; however, the supply mix will change considerably once the desalination plant becomes operational.

This 54-inch diameter pipeline is just about at its maximum capacity to convey the peak summer flows to the Aguaje de La Tuna Reservoir and numerous delivery points along the way under present conditions. Upon construction of the desalting facilities in Rosarito, the flows conveyed by this pipeline will be significantly reduced;

thereby making Colorado River water available to new developments to the north and northeast of the El Florido Water Treatment Plant. However, it should be noted that if the desalting facilities are postponed for a certain period of time and deliveries from the emergency connection with the United States become available at the Otay system, additional flows from the El Florido Water Treatment Plant, may be available for the Aguaje de la Tuna and Zona Rio systems. These flows may exceed the carrying capacity of this pipeline and may require the construction of a low head pump station to increase the hydraulic gradient. This pump station is not recommended at this time, but it should be closely considered depending on the supply mix of sources over the next 5 to 10 years.

10.2.2 Analysis of the Florido – Otay Aqueduct

This aqueduct currently serves all the developed areas on the northerly side of the Tijuana River including the Airport, Otay, Cerro Colorado, Guaycura, Matamoros, and Aztecas systems. To simplify the analysis of this large portion of the CESPT service area, this aqueduct is divided into three main segments as follows:

- Otay Reservoir to Airport Reservoir
- Cerro Colorado Reservoir to Otay Reservoir
- El Florido Water Treatment Plant to Cerro Colorado Reservoir

10.2.2.1 Analysis of the Otay Reservoir to Aeropuerto Reservoir Section

The main transmission in this segment consist of a 910 mm (36 inches) in diameter pipeline that runs along the United States border and feeds by gravity the Aeropuerto Reservoir and through a pressure reducing station the Murua Reservoir. The line that serves the Aeropuerto Reservoir consists of a 510 mm (20 inch) diameter pipeline. The Murua system is fed by a 610 mm (24 inch) and a 760 mm (30 inch) pipelines that serve the University, Murua, Central Camionera, Planta X9 and other smaller subsystems. The main line along the border also serves Ciudad Industrial, Garita, and other smaller subsystems.

Under current conditions, this system is supplied by the El Florido Water Treatment Plant through the Otay Reservoir. Presently, the maximum day demand is estimated at 572 l/s (9,100 gpm). This demand is anticipated to increase to 708 l/s (11,250 gpm) by the year 2023. The current transmission facilities are adequately sized to meet current and projected maximum demands; therefore, no improvements are recommended.

By 2003, the supply mix to this area is anticipated to change by the activation of the emergency connection with the United States. As discussed in previous sections, this connection will provide supplemental water to the Tijuana system while new sources of supply are developed. The ultimate development of desalting facilities will not impact this portion of this system since it will continue being fed by the El Florido

Water Treatment Plant. Neither the use of the emergency connection with the United States nor the implementation of the desalting facility in Playas de Rosarito would have a hydraulic effect on this system.

From a storage perspective, the current and projected maximum demands will require a total storage of 16,500 and 20,400 cubic meters. The current storage capacity of this system, estimated at 30,000 cubic meters, is adequate to meet current and projected requirements. Storage facilities in this system include:

Component	Capacity (m^3)
Otay	20,000
Murúa	5,000
Aeropuerto	5,000

10.2.2.2 Analysis of the Cerro Colorado to Otay Reservoir Section

The transmission facilities between these reservoirs range in size from 910 mm to 1,220 mm (36 to 48 inches) in diameter. This system primarily feeds the Otay Reservoir and the Guaycura, Matamoros, and Azteca sub-systems. The Guaycura branch consists of a 410 mm to 510 mm pipeline that feeds the Ampliacion Guaycura Reservoir. The current maximum day demand for the Guaycura system of 405 l/s (6,500 gpm) is anticipated to increase to 646 l/s (10,250 gpm) by the year 2023 as the area continues to develop. The existing pipeline is adequately sized to meet current demands; however, for future demands, the section of the pipeline between the Cerro Colorado Aqueduct and the Buenos Aires system would approach maximum velocities. However, it is anticipated that the system would have enough residual pressure to deliver anticipated maximum flows to the Ampliacion Guaycura Reservoir and may not require replacement.

The Matamoros sub-system is fed by a 610 mm (24-inches) pipeline, that feeds the Ejido Matamoros Reservoir through the Matamoros pump station. Maximum day demand for this subsystem is estimated to increase from the current 68 l/s (1,100 gpm) to an estimated 168 l/s (2,700 gpm) by the year 2023. The existing pipeline has enough capacity to carry current and projected water demands. The capacity of the pump station was not evaluated because of the lack of data.

The Azteca system comprises the Azteca, Presidentes, Capistrano, Aguila, Zona Rio 3ra Etapa and other smaller subsystems. This system was modeled as a demand point off the Cerro Colorado Aqueduct since it is considered a secondary system and most of the existing pipelines are small in diameter. Maximum day demand, currently estimated at 197 l/s (3,100 gpm) is anticipated to increase to 290 l/s (4,600 gpm) by the year 2023. A cursory review of the existing pipelines indicates that they may be undersized to meet projected demands and new pipelines would be required. It is recommended that CESPT develops a detailed model of this portion of the system to address the adequacy of existing facilities.

From a storage perspective, the existing Cerro Colorado Reservoir (20,000 cubic meter storage capacity) and other smaller reservoirs in the area provide enough storage capacity to meet current requirements estimated at 19,300 cubic meters. However, additional storage capacity will be required to meet the 2023 requirements of 31,800 cubic meters. It is recommended that a 5,000 cubic meter reservoir be constructed in the Guaycura system.

10.2.2.3 Analysis of the El Florido Water Treatment Plant to Cerro Colorado Aqueduct

The purpose of this aqueduct is to convey treated water from the El Florido Water Treatment Plant to the Cerro Colorado Reservoir. Along the way, the aqueduct serves a handful of small subsystems. This aqueduct, ranging in size between 1,220 mm and 1,370 mm (48 to 54 inches), has enough capacity to convey current maximum day demands, estimated at 1,450 l/s (23,000 gpm), as well as projected maximum demands for the year 2023 (2,250 l/s or 35,700 gpm). No improvements are required.

10.2.3 Analysis of the El Florido Water Treatment Plant to the Fiadert Reservoir Aqueduct

This aqueduct consists of a 610 mm (24-inches) in diameter pipeline that conveys treated water from the plant to this new reservoir located at an elevation of 223 m (730 ft). There is no topographic information along the pipeline route to determine operating pressures in the system. Assuming that there are no high points in between the El Florido Water Treatment Plant and the reservoir, the maximum capacity of this pipeline is estimated between 400 and 450 l/s (6,300 to 7,100 gpm). This capacity is adequate to meet the estimated maximum day demand of 267 l/s (4,250 gpm) under current conditions; however, it will be undersized to convey the projected maximum day demand for the year 2023, which is estimated at 600 l/s (9,500 gpm).

Storage requirements for this system range from 7,700 cubic meters to 17,300 cubic meters for the year 2023. Current storage capacity is limited to a 4,700 cubic meters reservoir. Three 5,000 cubic meter reservoirs are proposed for this area to serve future developments.

10.2.4 Summary of Proposed Improvements for the Developed Area

In general, the existing transmission, storage and pumping system is adequate to meet current maximum day demands. Most of the transmission lines have capacity to accommodate additional flows with the exception of some portions of the El Florido to Aguaje de La Tuna Aqueduct. The analysis of the existing system and proposed facilities considered current conditions and the integration of the preferred alternative (Alternative F-E). This alternative includes the development of significant supply sources from desalted water and requires the construction of a fairly large desalination plant in Playas de Rosarito. The integration of desalted water into the system will result in significant operational changes that will be required to make

good use of this source. Figure 10-2 shows the proposed improvements in the area that is currently developed. The recommended transmission, pumping, and storage improvements are summarized below.

Transmission Improvements

- 2,000 m (6,560 ft) of 300 mm (12") diameter line between the Playas 1 and Playas 2 Reservoir
- 800 m (2,600 ft) of 610 mm (24") diameter line to convey water from the Playas 2 to the Lazaro Cardenas 2 Reservoir
- 2,650 m (8,700 ft) of 610 mm (24") diameter line to convey water from the Panamericano to the Aguaje de La Tuna Reservoir

Storage Improvements

- 5,000 cubic meter storage reservoir in the Guaycura service area
- Three 5,000 cubic meter storage reservoir in the Fiadert System

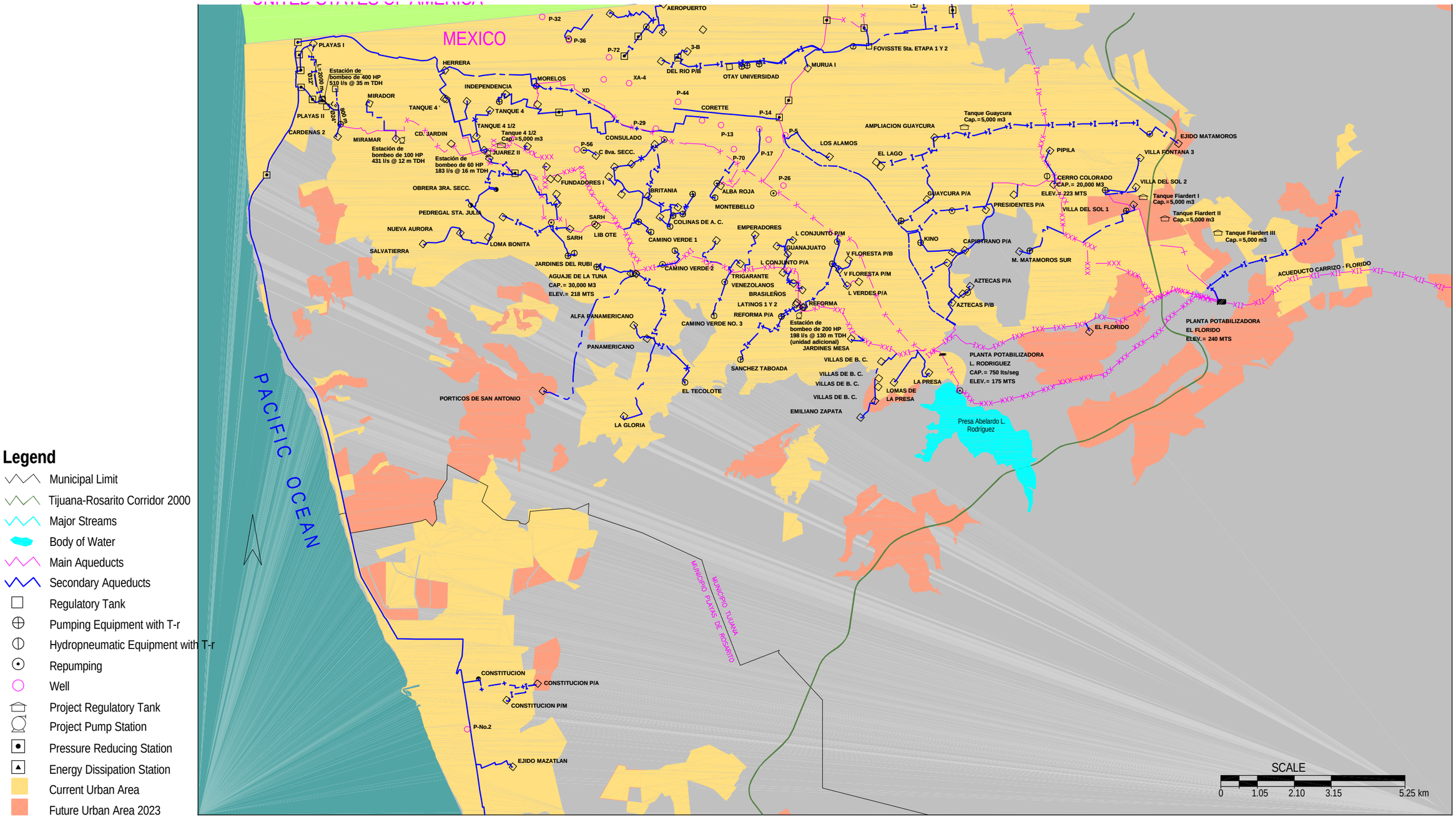
Pumping Improvements

- 400 Hp new pump station to convey 510 lts (8,100 gpm) from the Playas 2 to the Miramar Reservoir. Discharge head estimated at 35 m (115 ft).
- 100 Hp new pump station to convey 431 lts (6,800 gpm) from the Miramar to the 4½ Reservoir. Discharge head estimated at 12 m (39 ft).
- 200 Hp additional pumping unit at the Sanchez Taboada station to increase its capacity to 198 l/s (3,100 gpm). Discharge head estimated at 130 m (427 ft). Total horsepower required at station when developed would be 600 Hp. Existing piping at this station needs to be checked to assess whether existing station can handle additional flows.

10.3 Evaluation of Proposed Water System for Areas to be Developed

In general, the areas to be developed include the areas to the northeast of the exiting El Florido Water Treatment Plant, the Valle Dorado, Rosarito, and the areas east of Rosarito towards the El Panamericano Reservoir.

A total of 12 alternatives that combined a number of supply sources and wastewater treatment plant locations have been presented in previous sections. From a water perspective, these alternatives can be reduced to seven main alternatives since many of them have the same water supply, treatment and transmission elements.



Legend

- Municipal Limit
- Tijuana-Rosarito Corridor 2000
- Major Streams
- Body of Water
- Main Aqueducts
- Secondary Aqueducts
- Regulatory Tank
- Pumping Equipment with T-r
- Hydropneumatic Equipment with T-r
- Repumping
- Well
- Project Regulatory Tank
- Project Pump Station
- Pressure Reducing Station
- Energy Dissipation Station
- Current Urban Area
- Future Urban Area 2023

Figure 10-2
Recommended Infrastructure for Developed Areas (2002)

Prior to developing alternatives, the topography of the area to be developed was evaluated to determine the most feasible locations for primary reservoirs. Main reservoirs were identified at selected locations and their potential service areas outlined. Reservoirs in some cases were identified every 100 or 150 m (330 to 495 ft) of vertical separation. While this vertical separation would result in very high pressures, the intent was to identify the main reservoirs and not concentrate on smaller ones. Additional smaller reservoirs fed by the main reservoir should be constructed as these areas develop to address the specific conditions of a particular development or sub-area.

Once the main reservoir sites were defined and the location of supply sources and treatment plants identified, pipeline alignments were drawn to joint the potential sources with delivery points (reservoirs). It should be noted that the location and capacity of reservoirs is common to all alternatives; however, the alignment and length of proposed transmission facilities varies somewhat for each alternative since the supply sources are different. Table 10-1 presents the proposed reservoirs, recommended elevations, storage capacity, estimated population served, and anticipated maximum day demand.

The sizing of the pipelines between reservoirs and supply sources was based on the following criteria:

- Maximum velocity of 5 m/sec (15 ft/sec)
- Maximum head loss of 3.5 meter /1,000 meters of pipeline length (3.5 ft/1,000 ft)
- Available energy to convey required flows between source and delivery points

Pump stations were sized based on the estimated maximum delivery rates and the total dynamic head obtained from the model. Pump stations were sized assuming a 70 percent plant efficiency.

10.3.1 Analysis of Alternative B-B (Same as B-C, B-D and B-E)

This alternative has the same supply components as Alternatives B-C, B-D, and B-E. Under these alternatives, supplies from the Colorado River are kept constant at the present rate of supply (4,000 l/s). All of the additional demands are met by desalination of seawater (3,225 l/s). The existing El Florido Water Treatment Plant remains at its present capacity of 4,000 l/s while the Rosarito desalination plant provides salt removal for the remaining supply. Under this alternative, there is not groundwater production along the Tijuana and Alamar rivers nor there is indirect potable reuse of highly treated wastewater. Deliveries of desalted water to the currently developed area are estimated at 715 l/s to the Playas 2 Reservoir and 915 l/s to the Aguaje de La Tuna Reservoir through the Panamericano system.

Table 10-1 Proposed Storage Improvements for Non-Developed Areas						
	Elevation	Capacity		Population	Maximum Day Demand (2023)	
		m^3	Gallons		l/s	gpm
Area to the Northeast of the El Florido Treatment Plant						
Refugio	250	20,000	5,300,000	246,000	670	10,600
Carrizo 1	300	11,000	2,900,000	133,000	264	4,200
Carrizo 2	350	500	100,000	Industrial	12	200
Carrizo 3	440	2,000	500,000	6,300	64	1,000
Valle Dorado - Rosarito						
Valle Dorado	375	18,000	4,800,000	226,000	558	8,800
Rosarito 6	325	2,000	500,000	21,000	56	900
Rosarito 7	180	4,500	1,200,000	45,000	128	2,000
Rosarito 8	325	8,000	2,100,000	130,000	257	4,100
Area to the South of Playas de Rosarito						
Primo Tapia	190	2,000	500,000	12,000	48	800
Mesa del Descanso	120	500	100,000	6,000	12	200
Santa Anita	130	500	100,000	4,100	16	300
Area to the North of Playas de Rosarito						
San Antonio de Los Buenos	200	6,500	1,700,000	70,000	188	3,000
Total Additional Storage		**75,500**	**20,000,000**			

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-3. Pipeline improvements are summarized in Table 10-2 while pump station improvements are listed in Table 10-3 at the end of this section.

Table 10-2 Alternatives B-B, B-C, B-D, B-E - Proposed Transmission Lines			
Diameter		Length	
Mm	Inches	Meters	Feet
1,524	60	700	2,300
1,371	54	-	-
1,219	48	3,650	12,000
1,067	42	-	-
914	36	19,050	62,500
762	30	19,850	65,100
686	27	-	-
610	24	6,200	20,300
508	20	3,600	11,800
406	16	7,000	23,000
305	12	16,800	55,100
Total		**78,850**	**252,100**

Legend

- Municipal Limit
- Existing Connection Lines
- Project Connection Lines
- Existing Regulatory Tank
- Project Regulatory Tank
- Project Desalinization Plant
- Existing Water Treatment Tank
- Project Water Treatment Tank
- Groundwater
- Pump Station

Influential zones of the Tanks

- Fraccionamiento Valle Dorado
- Rosarito 6
- Rosarito 7
- Rosarito 8 (Constitución)
- Rancho el Tecolote
- San Antonio de los Buenos
- Carrizo 1
- Carrizo 2
- Carrizo 3
- Refugio
- Primo Tapia
- Mesa del Descanso
- Santa Anita
- Playas II
- Aguaje de la Tuna
- Cerro colorado-Otay

Influential zones of

- Wells
- Los Olivos and Abelardo L. Rodríguez 1 WTP

Note: all indicated flows in the figure include population, commerce, industry and government

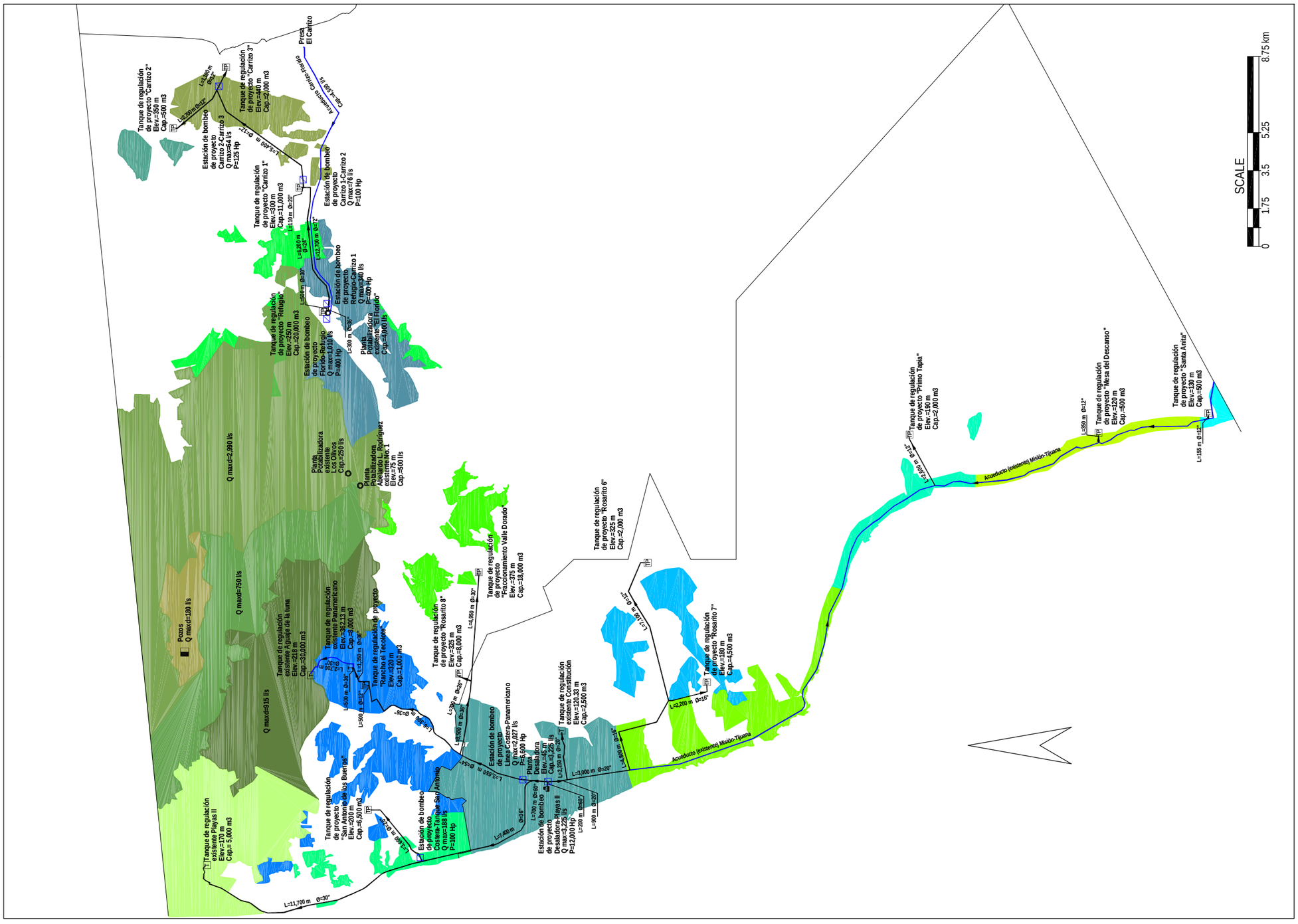


Figure 10-3
Alternative BB, Recommended Infrastructure for Non-developed Areas

Table 10-3 Alternatives B-B, B-C, B-D, B-E - Proposed Pumping Stations								
Pumping Station	**From**	**To**	**Flow Rate**		**Pressure**		**Horse Power @ 70% Efficiency**	
			lts	**gpm**	**m**	**feet**	**Needed**	**Recommended**
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Desaladora - Playas II	Desaladora	Playas II	3,225	51,117	193	633	11,677	12,000
Desaladora - Panamericano	Linea Costera	Panamericano	2,027	32,129	170	558	6,464	6,600
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
							Total Hp	**19,725**

10.3.2 Analysis of Alternative F-B (Same as F-C)

This alternative has the same supply components as Alternative F-C. Under these alternatives supplies from the Colorado River are kept constant at the present rate of supply (4,000 l/s). All of the additional demands are met by a combination of desalination of seawater (2,450 l/s), local groundwater from the Tijuana and Alamar rivers treated at the new Alamar Water Treatment Plant (300 l/s), indirect potable reuse (476 l/s). The existing El Florido Water Treatment Plant remains at its present capacity of 4,000 l/s; the existing A.L. Rodriguez Water Treatment Plant is refurbished to produce 500 l/s and a new plant (Rodriguez 2) is proposed to treat an additional 475 l/s off the Rodriguez Reservoir. Deliveries of desalted water to the currently developed area are estimated at 415 l/s to the Playas 2 Reservoir and 915 l/s to the Aguaje de La Tuna Reservoir through the Panamericano system.

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-4. Pipeline improvements are presented in Table 10-4 while pump station improvements are listed in Table 10-5 at the end of this section.

Table 10-4 Alternatives F-B, F-C - Proposed Transmission Lines			
Diameter		**Length**	
mm	**Inches**	**Meters**	**Feet**
1,524	60	-	-
1,371	54	700	2,300
1,219	48	3,650	12,000
1,067	42	-	-
914	36	8,150	26,700
762	30	10,600	34,800
686	27	11,700	38,400
610	24	22,400	73,500

Table 10-4 Alternatives F-B, F-C - Proposed Transmission Lines			
Diameter		**Length**	
mm	**Inches**	**Meters**	**Feet**
508	20	3,600	11,800
406	16	10,750	35,300
305	12	16,800	55,100
	Total	**88,350**	**289,900**

Table 10-5 Alternatives F-B, F-C - Proposed Pumping Stations								
Pumping Station	**From**	**To**	**Flow Rate**		**Pressure**		**Horse Power @ 70% Efficiency**	
			lts	**gpm**	**m**	**feet**	**Needed**	**Recommended**
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Planta Rodriguez 2	Planta Rodriguez 2	Panamericano	475	7,529	170	558	1,515	1,600
Presa Rodriguez	Presa Rodriguez	Planta Rodriguez 2	475	7,529	60	197	535	600
Desaladora - Playas II	Desaladora	Playas II	2,450	38,833	165	541	7,584	7,600
Desaladora - Panamericano	Linea Costera	Panamericano	1,552	24,600	185	607	5,386	5,400
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
Planta Alamar	Planta Alamar	Tanque Otay	300	4,755	96	315	540	600
							Total Hp	**16,925**

10.3.3 Analysis of Alternative F-D

This alternative is very similar to the previous Alternative F-B. The only difference between these alternatives is that the local groundwater production from the Tijuana and Alamar rivers is eliminated and replaced by additional desalination of seawater. Under this alternative, supplies from the Colorado River are kept constant at the present rate of supply (4,000 l/s). All of the additional demands are met by a combination of desalination of seawater (2,750 l/s), indirect potable reuse (476 l/s). The existing El Florido Water Treatment Plant remains at its present capacity of 4,000 l/s; the existing A.L. Rodriguez Water Treatment Plant is refurbished to produce 500 l/s and a new plant (Rodriguez 2) is proposed to treat an additional 475 l/s off the Rodriguez Reservoir. Deliveries of desalted water to the currently developed area are estimated at 816 l/s to the Playas 2 Reservoir and 817 l/s to the Aguaje de La Tuna Reservoir through the Panamericano system.

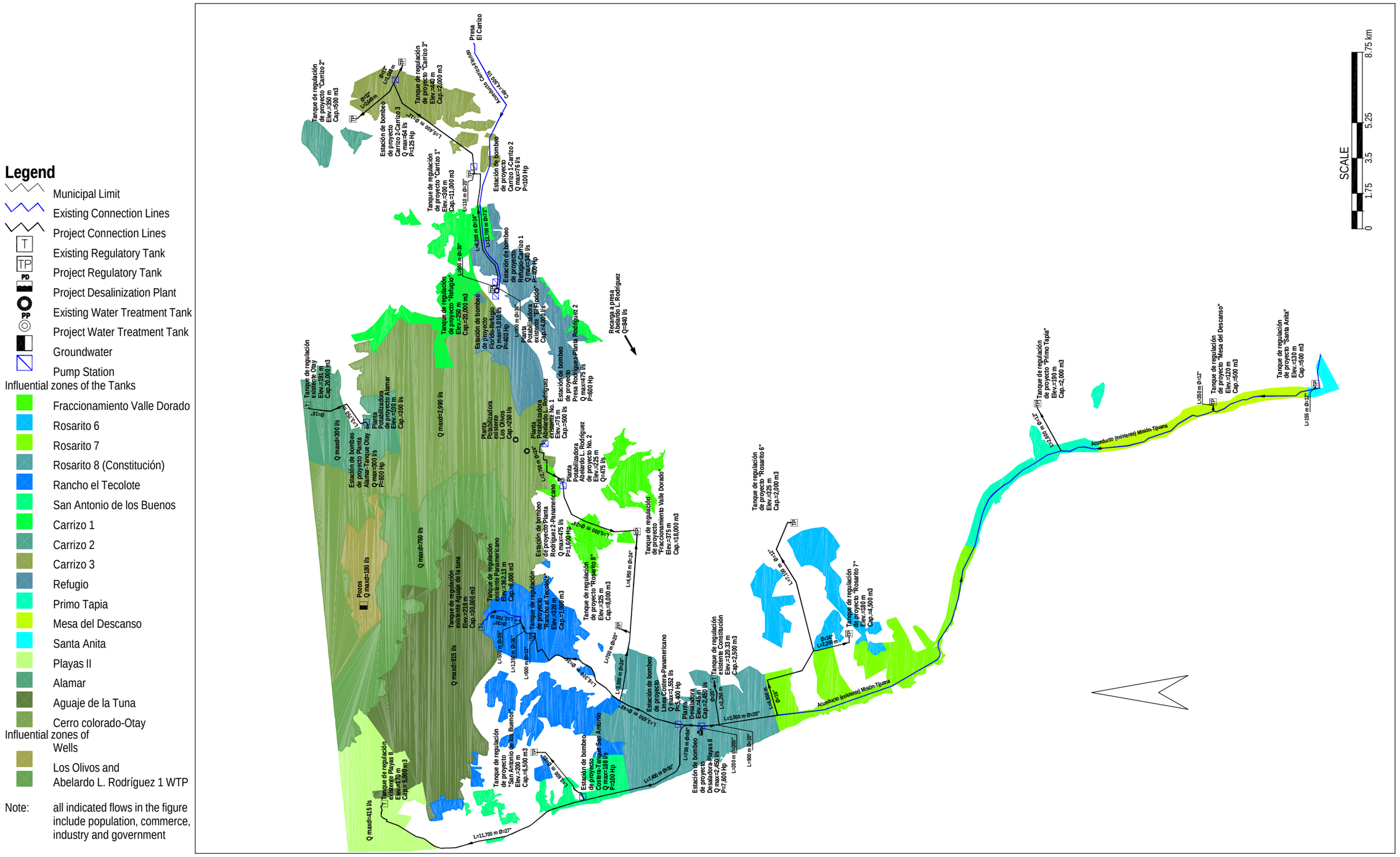


Figure 10-4
Alternative FB, Recommended Infrastructure for Non-developed Areas

CDM

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-5. Pipeline improvements are presented in Table 10-6 while pump station improvements are listed in Table 10-7 at the end of this section.

Table 10-6
Alternative F-D - Proposed Transmission Lines

Diameter		Length	
mm	**Inches**	**Meters**	**Feet**
1,524	60	700	2,300
1,371	54	-	-
1,219	48	-	-
1,067	42	3,650	12,000
914	36	15,550	51,000
762	30	14,900	48,900
686	27	-	-
610	24	22,400	73,500
508	20	3,600	11,800
406	16	7,000	23,000
305	12	16,800	55,100
	Total	**84,600**	**277,600**

Table 10-7
Alternative F-D - Proposed Pumping Stations

Pumping Station	From	To	Flow Rate		Pressure		Horse Power @ 70% Efficiency	
			lts	gpm	m	feet	Needed	Recommended
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Planta Rodriguez 2	Planta Rodriguez 2	Panamericano	475	7,529	170	558	1,515	1,600
Presa Rodriguez	Presa Rodriguez	Planta Rodriguez 2	475	7,529	60	197	535	600
Desaladora - Playas II	Desaladora	Playas II	2,750	43,588	193	633	9,957	10,000
Desaladora - Panamericano	Linea Costera	Panamericano	1,451	22,999	170	558	4,628	4,700
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
							Total Hp	**18,025**

Legend

- Municipal Limit
- Existing Connection Lines
- Project Connection Lines
- Existing Regulatory Tank
- Project Regulatory Tank
- Project Desalinization Plant
- Existing Water Treatment Tank
- Project Water Treatment Tank
- Groundwater
- Pump Station

Influential zones of the Tanks

- Fraccionamiento Valle Dorado
- Rosarito 6
- Rosarito 7
- Rosarito 8 (Constitución)
- Rancho el Tecolote
- San Antonio de los Buenos
- Carrizo 1
- Carrizo 2
- Carrizo 3
- Refugio
- Primo Tapia
- Mesa del Descanso
- Santa Anita
- Playas II
- Aguaje de la Tuna
- Cerro colorado-Otay

Influential zones of

- Wells
- Los Olivos and Abelardo L. Rodríguez 1 WTP

Note: all indicated flows in the figure include population, commerce, industry and government

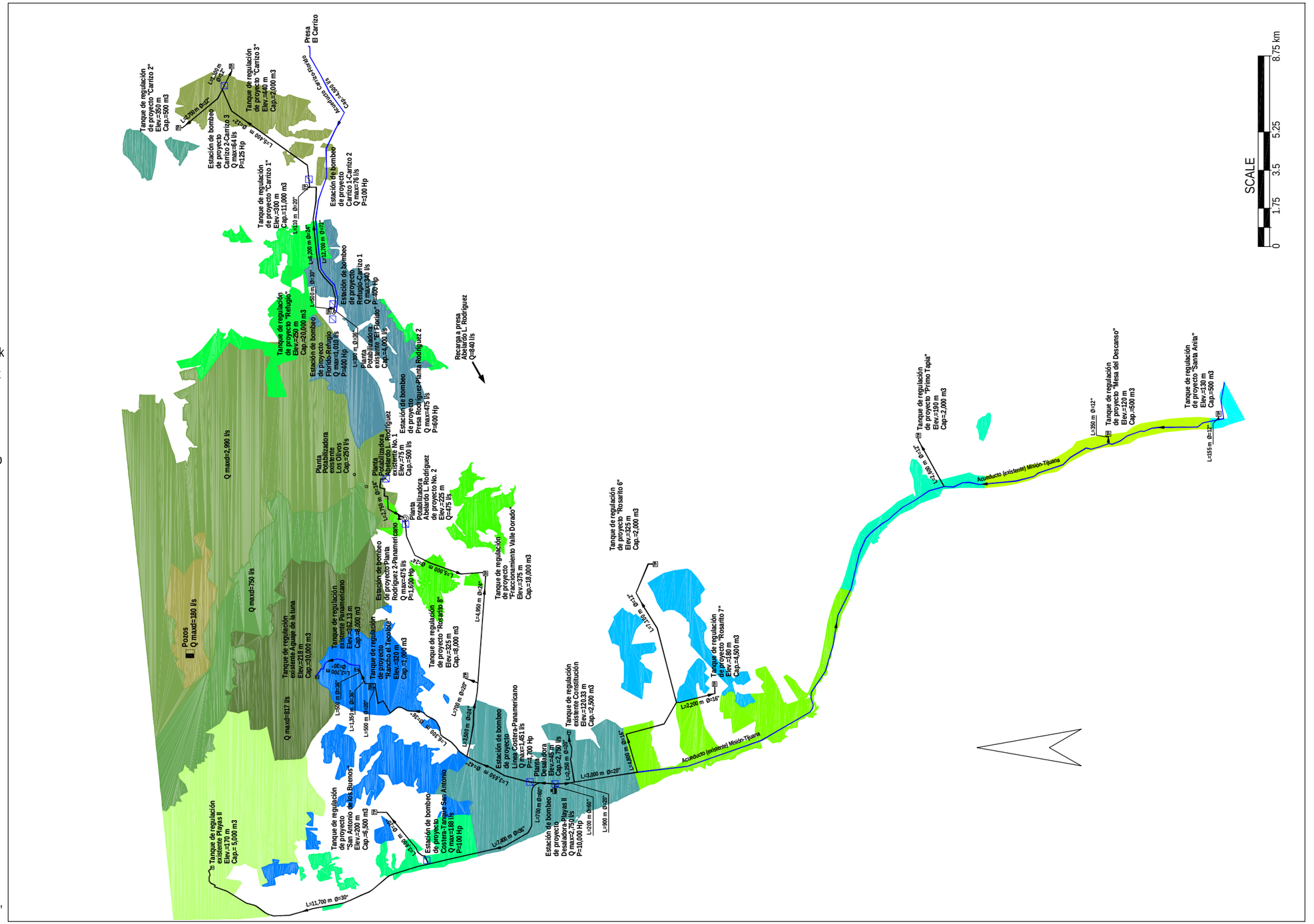


Figure 10-5
Alternative FD, Recommended Infrastructure for Non-developed Areas

CDM

10.3.4 Analysis of Alternative F-E

Under this alternative, supplies from the Colorado River are kept constant at the present rate of supply (4,000 l/s). Desalination of seawater is reduced to 2,170 l/s while indirect potable reuse is increased to 754 l/s representing the highest rate of reuse amongst all alternatives. Groundwater production is kept at 300 l/s at the new Alamar Water Treatment Plant. The existing El Florido Water Treatment Plant remains at its present capacity of 4,000 l/s; the existing A.L. Rodriguez Water Treatment Plant is refurbished to produce 500 l/s and a new plant (Rodriguez 2) is proposed to treat an additional 751 l/s off the Rodriguez Reservoir. Deliveries of desalted water to the currently developed area are estimated at 666 l/s to the Playas 2 Reservoir and 667 l/s to the Aguaje de La Tuna Reservoir through the Panamericano system.

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-6. Pipeline improvements are presented in Table 10-8 while pump station improvements are listed in Table 10-9 at the end of this section.

Table 10-8
Alternative F-E - Proposed Transmission Lines

Diameter		Length	
mm	**Inches**	**Meters**	**Feet**
1,524	60	-	-
1,371	54	700	2,300
1,219	48	-	-
1,067	42	3,650	12,000
914	36	15,550	51,000
762	30	19,950	65,500
686	27	-	-
610	24	17,350	56,900
508	20	3,600	11,800
406	16	10,750	35,300
305	12	16,800	55,100
	Total	**88,350**	**289,900**

Table 10-9
Alternative F-E - Proposed Pumping Stations

Pumping Station	From	To	Flow Rate		Pressure		Horse Power @ 70% Efficiency	
			lts	gpm	m	feet	Needed	Recommended
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Planta Rodriguez 2	Planta Rodriguez 2	Panamericano	475	7,529	170	558	1,515	1,600
Presa Rodriguez	Presa Rodriguez	Planta Rodriguez 2	475	7,529	60	197	535	600
Desaladora - Playas II	Desaladora	Playas II	2,750	43,588	193	633	9,957	10,000
Desaladora - Panamericano	Linea Costera	Panamericano	1,451	22,999	170	558	4,628	4,700
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
Planta Alamar	Planta Alamar	Tanque Otay	300	4,755	96	315	540	600
							Total Hp	**18,625**

Legend

- Municipal Limit
- Existing Connection Lines
- Project Connection Lines
- Existing Regulatory Tank
- Project Regulatory Tank
- Project Desalinization Plant
- Existing Water Treatment Tank
- Project Water Treatment Tank
- Groundwater
- Pump Station

Influential zones of the Tanks

- Fraccionamiento Valle Dorado
- Rosarito 6
- Rosarito 7
- Rosarito 8 (Constitución)
- Rancho el Tecolote
- San Antonio de los Buenos
- Carrizo 1
- Carrizo 2
- Carrizo 3
- Refugio
- Primo Tapia
- Mesa del Descanso
- Santa Anita
- Playas II
- Alamar
- Aguaje de la Tuna
- Cerro colorado-Otay

Influential zones of

- Wells
- Los Olivos and Abelardo L. Rodríguez 1 WTP

Note: all indicated flows in the figure include population, commerce, industry and government

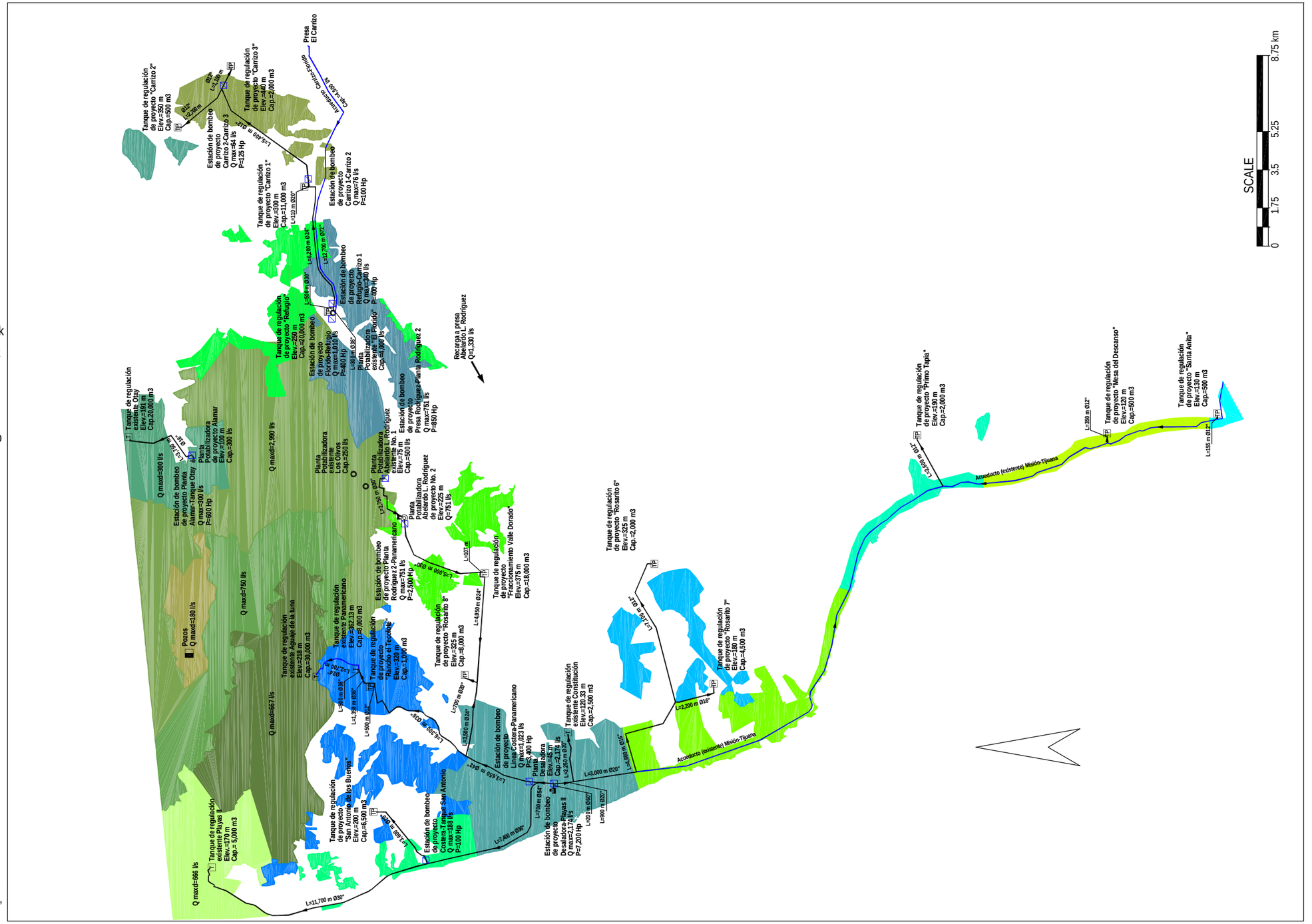


Figure 10-6
Alternative FE, Recommended Infrastructure for Non-developed Areas

CDM

10.3.5 Analysis of Alternative G-B (Same as G-C)

This alternative has the same supply components as Alternative G-C. Under these alternatives supplies from the Colorado River are augmented to 5,757 l/s while desalination is significantly reduced to 691 l/s. Groundwater production is maintained at 300 l/s at the Alamar Water Treatment Plant. Indirect potable reuse provides 476 l/s under this alternative. To accommodate the increase in deliveries of imported water a new delivery pipeline from the El Carrizo Reservoir to the El Valle Dorado area will be required to convey raw water to a new 1,757 l/s treatment plant in that location. In addition, the existing A.L. Rodriguez Water Treatment Plant would be refurbished to produce 500 l/s and a new plant (Rodriguez 2) is proposed to treat an additional 475 l/s off the Rodriguez Reservoir. Deliveries of desalted water to the currently developed area are limited to 505 l/s to the Playas 2 Reservoir while deliveries of Colorado River water from the Valle Dorado Water Treatment Plant to the Aguaje de La Tuna Reservoir are estimated at 826 l/s.

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-7. Pipeline improvements are presented in Table 10-10 while pump station improvements are listed in Table 10-11 at the end of this section.

Table 10-10
Alternatives G-B, G-C - Proposed Transmission Lines

Diameter		Length	
mm	**Inches**	**Meters**	**Feet**
1,524	60	29,200	95,800
1,371	54	-	-
1,219	48	-	-
1,067	42	-	-
914	36	20,900	68,600
762	30	14,700	48,200
686	27	11,700	38,400
610	24	19,450	63,800
508	20	3,600	11,800
406	16	18,850	61,800
305	12	20,200	66,300
	Total	**138,600**	**454,700**

Legend

- Municipal Limit
- Existing Connection Lines
- Project Connection Lines
- Existing Regulatory Tank
- Project Regulatory Tank
- Project Desalinization Plant
- Existing Water Treatment Tank
- Project Water Treatment Tank
- Groundwater
- Pump Station

Influential zones of the Tanks

- Fraccionamiento Valle Dorado
- Rosarito 6
- Rosarito 7
- Rosarito 8 (Constitución)
- Rancho el Tecolote
- San Antonio de los Buenos
- Carrizo 1
- Carrizo 2
- Carrizo 3
- Refugio
- Primo Tapia
- Mesa del Descanso
- Santa Anita
- Playas II
- Alamar
- Aguaje de la Tuna
- Cerro colorado-Otay

Influential zones of

- Wells
- Los Olivos and Abelardo L. Rodríguez 1 WTP

Note: all indicated flows in the figure include population, commerce, industry and government

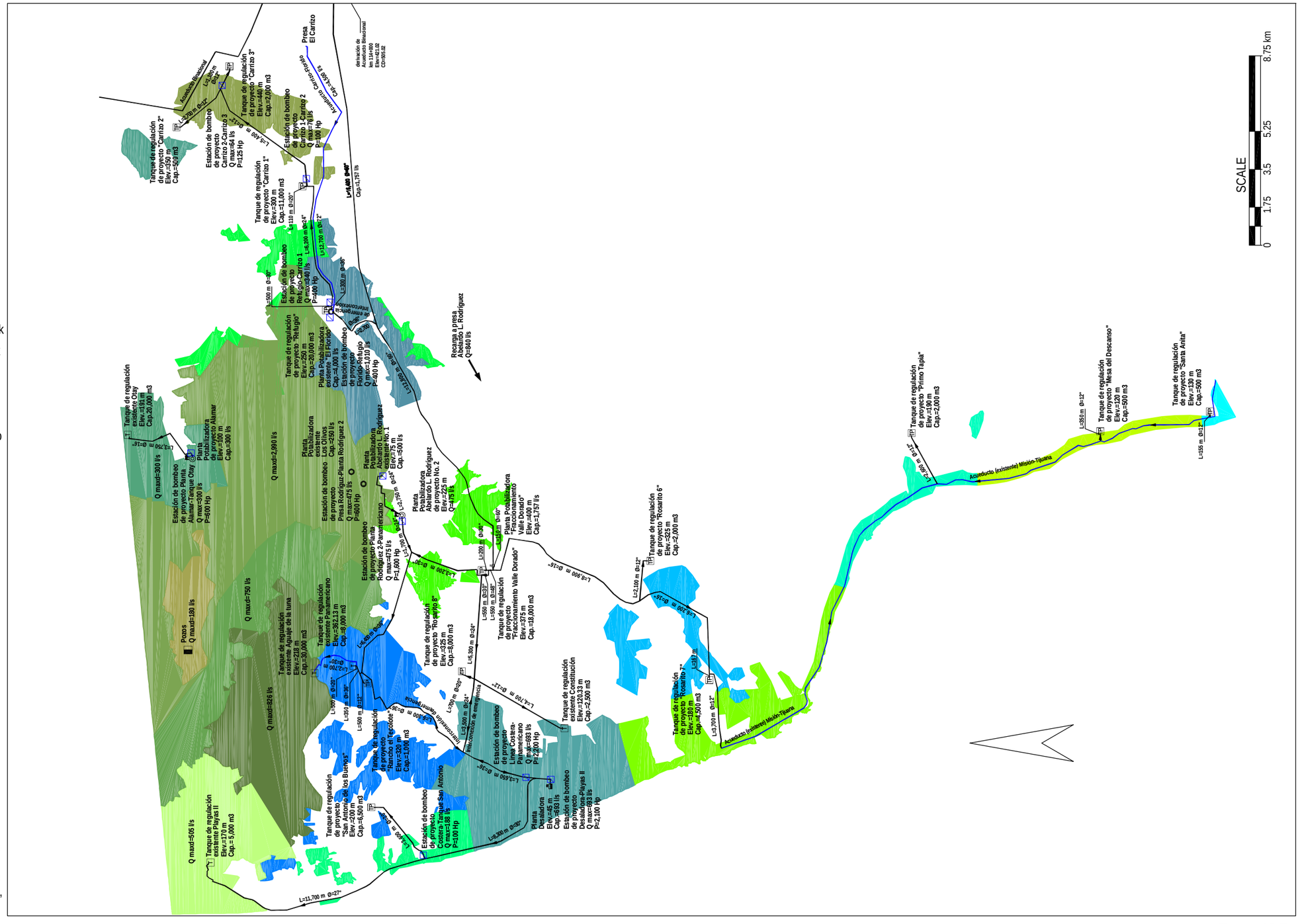


Figure 10-7
Alternative GB, Recommended Infrastructure for Non-developed Areas

CDM

Table 10-11
Alternatives G-B, G-C - Proposed Pumping Stations

Pumping Station	From	To	Flow Rate		Pressure		Horse Power @ 70% Efficiency	
			lts	gpm	m	feet	Needed	Recommended
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Planta Rodriguez 2	Planta Rodriguez 2	Panamericano	475	7,529	170	558	1,515	1,600
Presa Rodriguez	Presa Rodriguez	Planta Rodriguez 2	475	7,529	60	197	535	600
Desaladora - Playas II	Desaladora	Playas II	693	10,984	155	509	2,015	2,100
Desaladora - Panamericano	Linea Costera	Panamericano	693	10,984	170	558	2,210	2,200
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
Planta Alamar	Planta Alamar	Tanque Otay	300	4,755	96	315	540	600
							Total Hp	**8,225**

10.3.6 Analysis of Alternative G-D

Similar to the previous alternative, supplies from the Colorado River are augmented to 5,757 l/s while desalination is significantly reduced to 992 l/s. Indirect potable reuse provides 476 l/s under this alternative. The increase in deliveries from the Colorado River, are treated at the Valle Dorado Water Treatment Plant as described in the previous alternative. The existing A.L. Rodriguez Water Treatment Plant would be refurbished to produce 500 l/s and a new plant (Rodriguez 2) is proposed to treat an additional 475 l/s off the Rodriguez Reservoir. Deliveries of desalted water to the currently developed area are estimated at 510 l/s to the Playas 2 Reservoir while new deliveries from the Valle Dorado Water Treatment Plant to the Aguaje de La Tuna Reservoir are estimated at 1,120 l/s.

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-8. Pipeline improvements are presented in Table 10-12 while pump station improvements are listed in Table 10-13 at the end of this section.

Table 10-12 Alternative G-D - Proposed Transmission Lines			
Diameter		**Length**	
mm	**Inches**	**Meters**	**Feet**
1,524	60	29,200	95,800
1,371	54	-	-
1,219	48	-	-
1,067	42	5,800	19,000
914	36	17,500	57,400
762	30	11,500	37,700
686	27	11,700	38,400
610	24	16,950	55,600
508	20	3,600	11,800
406	16	10,750	35,300
305	12	16,800	55,100
	Total	**123,800**	**406,100**

Table 10-13 Alternative G-D - Proposed Pumping Stations								
Pumping Station	**From**	**To**	**Flow Rate**		**Pressure**		**Horse Power @ 70% Efficiency**	
			lts	**gpm**	**m**	**feet**	**Needed**	**Recommended**
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Planta Rodriguez 2	Planta Rodriguez 2	Panamericano	475	7,529	170	558	1,559	1,600
Presa Rodriguez	Presa Rodriguez	Planta Rodriguez 2	475	7,529	60	197	535	600
Desaladora - Playas II	Desaladora	Playas II	993	15,739	155	509	2,887	2,900
Desaladora - Panamericano	Linea Costera	Panamericano	993	15,739	185	607	3,446	3,500
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
Rosarito 6	Union con Rosarito 7	Rosarito 6	56	888	170	558	179	200
Rosarito 7	Union con Rosarito 6	Rosarito 7	128	2,029	18	59	43	50
Planta Alamar	Planta Alamar	Tanque Otay	300	4,755	96	315	540	600
							Total Hp	**9,775**

Legend

- Municipal Limit
- Existing Connection Lines
- Project Connection Lines
- Existing Regulatory Tank
- Project Regulatory Tank
- Project Desalinization Plant
- Existing Water Treatment Tank
- Project Water Treatment Tank
- Groundwater
- Pump Station

Influential zones of the Tanks

- Fraccionamiento Valle Dorado
- Rosarito 6
- Rosarito 7
- Rosarito 8 (Constitución)
- Rancho el Tecolote
- San Antonio de los Buenos
- Carrizo 1
- Carrizo 2
- Carrizo 3
- Refugio
- Primo Tapia
- Mesa del Descanso
- Santa Anita
- Playas II
- Aguaje de la Tuna
- Cerro colorado-Otay

Influential zones of

- Wells
- Los Olivos and Abelardo L. Rodríguez 1 WTP

Note: all indicated flows in the figure include population, commerce, industry and government

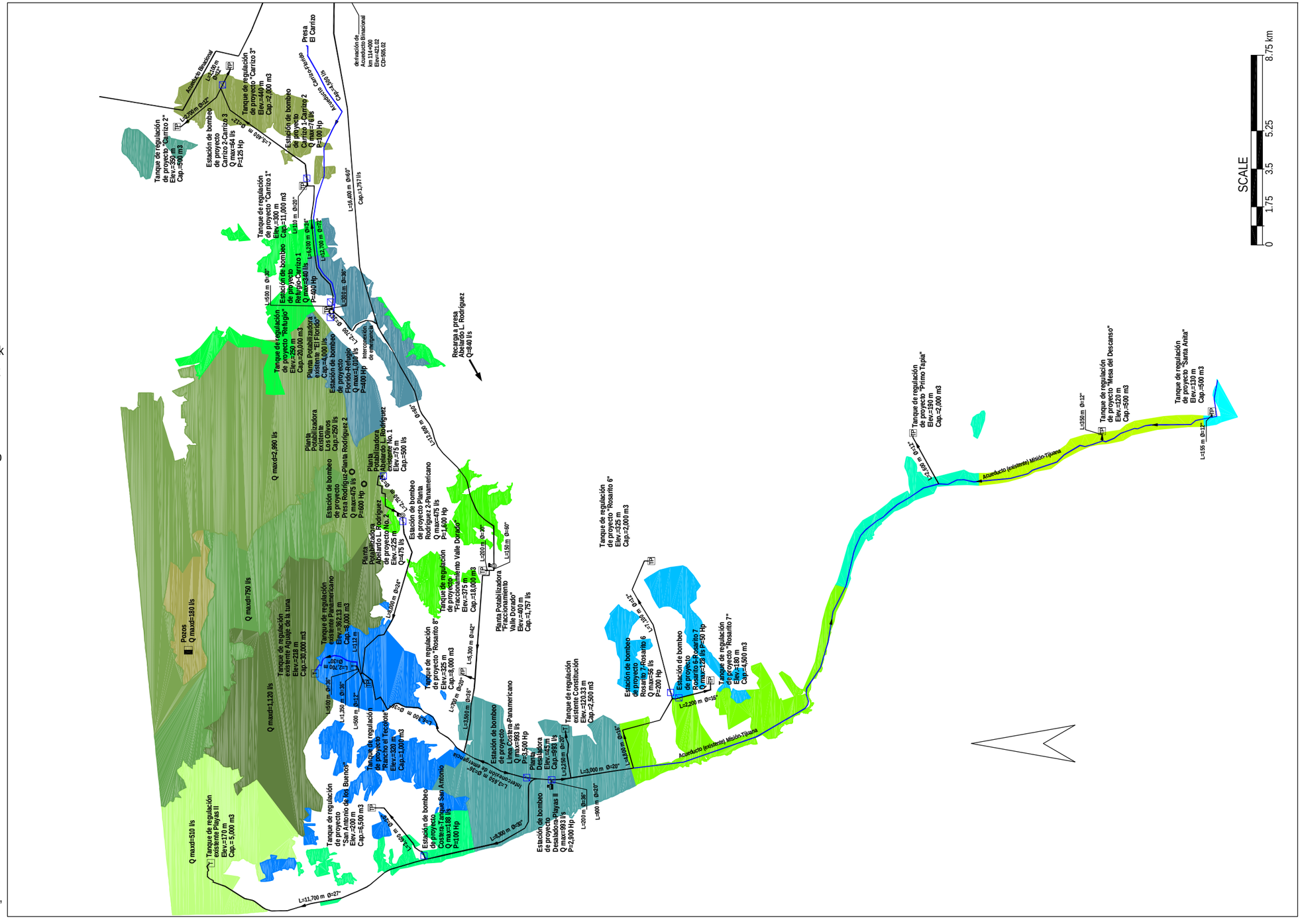


Figure 10-8
Alternative GD, Recommended Infrastructure for Non-developed Areas

10.3.7 Analysis of Alternative G-E

This alternative is very similar to Alternative G-B in that Colorado River deliveries are increased by 1,757 l/s and groundwater production at the new Alamar Water Treatment Plant is maintained at 300 l/s. Desalination of seawater is further reduced to only 413 l/s. The reduction in desalination is compensated by, increasing indirect potable reuse to 754 l/s. The increase in deliveries from the Colorado River, are treated at the Valle Dorado Water Treatment Plant as described in Alternative G-B. The existing A.L. Rodriguez Water Treatment Plant would be refurbished to produce 500 l/s and a new plant (Rodriguez 2) is proposed to treat an additional 751 l/s off the Rodriguez Reservoir. Deliveries of desalted water to the currently developed area are estimated at 229 l/s to the Playas 2 Reservoir while new deliveries from the Valle Dorado Water Treatment Plant to the Aguaje de La Tuna Reservoir are estimated at 1,102 l/s.

The proposed water treatment plants, transmission, storage and pumping facilities are depicted in Figure 10-9. Pipeline improvements are presented in Table 10-14 while pump station improvements are listed in Table 10-15 at the end of this section.

Table 10-14
Alternative G-E - Proposed Transmission Lines

Diameter		Length	
mm	**Inches**	**Meters**	**Feet**
1,524	60	29,200	95,800
1,371	54	-	-
1,219	48	-	-
1,067	42	8,250	27,100
914	36	2,700	8,900
762	30	19,150	62,800
686	27	-	-
610	24	21,150	69,400
508	20	3,600	11,800
406	16	18,850	61,800
305	12	20,200	66,300
	Total	**123,100**	**403,900**

Table 10-15 Alternative G-E - Proposed Pumping Stations								
Pumping Station	**From**	**To**	**Flow Rate**		**Pressure**		**Horse Power @ 70% Efficiency**	
			lts	**gpm**	**m**	**feet**	**Needed**	**Recommended**
El Refugio	Planta El Florido	Tanque El Refugio	1,010	16,009	20	66	379	400
Carrizo 1	Tanque El Refugio	Carrizo 1	340	5,389	60	197	383	400
Carrizo 2	Carrizo 1	Carrizo 2	76	1,205	55	180	78	100
Carrizo 3	Carrizo 2	Carrizo 3	64	1,014	95	312	114	125
Planta Rodriguez 2	Planta Rodriguez 2	Panamericano	751	11,904	170	558	2,395	2,400
Presa Rodriguez	Presa Rodriguez	Planta Rodriguez 2	751	11,904	60	197	845	850
Desaladora-Alt A – Mas Bombeo	Desaladora	Playas II	417	6,610	210	659	1,643	1,700
Desaladora-Alt A – Mas Bombeo	Desaladora	Playas II	417	6,610	160	525	1,252	1,300
San Antonio de Los Buenos	Linea Costera	Tanque San Antonio	188	2,980	20	66	71	100
Planta Alamar	Planta Alamar	Tanque Otay	300	4,755	96	315	540	600
							Total Hp	**7,975**

Legend

- Municipal Limit
- Existing Connection Lines
- Project Connection Lines
- Existing Regulatory Tank
- Project Regulatory Tank
- Project Desalinization Plant
- Existing Water Treatment Tank
- Project Water Treatment Tank
- Groundwater
- Pump Station

Influential zones of the Tanks

- Fraccionamiento Valle Dorado
- Rosarito 6
- Rosarito 7
- Rosarito 8 (Constitución)
- Rancho el Tecolote
- San Antonio de los Buenos
- Carrizo 1
- Carrizo 2
- Carrizo 3
- Refugio
- Primo Tapia
- Mesa del Descanso
- Santa Anita
- Playas II
- Alamar
- Aguaje de la Tuna
- Cerro colorado-Otay

Influential zones of

- Wells
- Los Olivos and Abelardo L. Rodríguez 1 WTP

Note: all indicated flows in the figure include population, commerce, industry and government

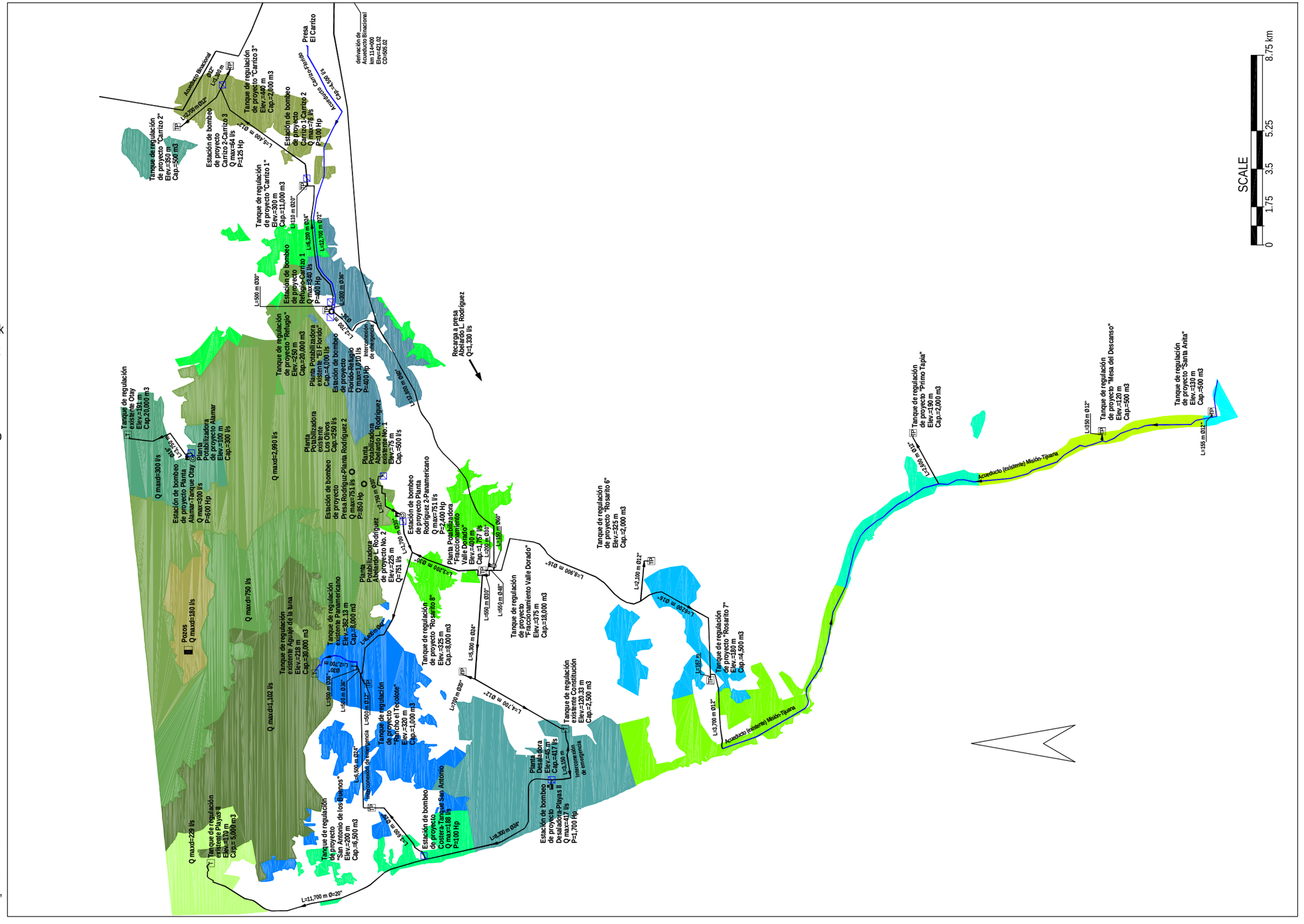


Figure 10-9
Alternative GE, Recommended Infrastructure for Non-developed Areas

CDM